

## *EXHIBIT N*

SUBJECT RIGHT REAR TIRE AND WHEEL

The subject right rear tire was identified by information molded on the sidewalls as follows:

GOODYEAR WRANGLER HT  
LT235/85R16 M+S  
LOAD RANGE: E  
MAXIMUM SINGLE LOAD: 3042 LBS @ 80 PSI  
MAXIMAUM DUAL LOAD: 2778 LBS @ 80 PSI  
TUBELESS RADIAL  
TREAD: 4 PLY, 2 PLY POLYESTER, 2 PLY STEEL  
SIDEWALL: 2 PLY POLYESTER  
DOT: MDORNJHV244

The DOT number indicates the subject right rear tire was manufactured by The Goodyear Tire & Rubber Company in Gadsden, Alabama during the 24<sup>th</sup> week of 1994.

The subject right rear wheel was a 16 X 6.5J wheel with a Top Seal TR 600HP rubber snap-in valve. The subject tire and wheel were separate during the examination.

My examination of the subject right rear tire revealed, as presented to me, a detachment of a portion of the tread and top steel belt. The average remaining tread groove depth was 8.5/32<sup>nds</sup> of an inch. The tread hardness measured 84 Shore A Durometer. There were a few stones embedded in the tread sipes. The serial side (outboard) tread shoulder was abraded in various areas 360 degrees.

The tire was a black sidewall tire. The tire was mounted with the serial side, outboard. Using a clock face as an approximate locating reference system with the DOT serial number at 12:00, the valve was located at 8:00.

The tread and top steal belt was detached and missing from 4:00 on the serial side and 6:00 on the opposite serial side to 10:30 on the serial side and 12:30 on the opposite serial side.

The tread and top steel belt was partially detached from 10:30 on the serial side and 12:30 on the opposite serial side to 1:00 on the serial side and 12:40 on the opposite serial side where still attached. The serial side top belt cord ends from 10:30 on the serial side to 12:00 on the opposite serial side were loose, bare, rusted, bent and tangled.

Overall, steel belt cords were adhered in rubber. There were exposed steel cords that were rusted.

The rubber remaining over bottom steel belt in detached region of crown was worn with lateral abrasion marks.

At 11:50 in the crown region, there were four (4) broken bottom steel belt cords and filaments.

There was multi-level rubber tearing on all detached rubber surfaces. Additionally, there was multi-level tear lines along the serial side and opposite serial side bottom belt edge in detachment region.

There were a few permanent treads in bottom steel belt in detachment region.

There was a localized region of multi-level rubber (separation) tearing on serial side in rubber over bottom belt from 9:30 on the serial side to 12:00 on the opposite serial side extending to crown at 10:30.

There was a localized region of multi-level rubber (separation) tearing on the opposite serial side in rubber over bottom belt from 9:30 on the opposite serial side to 11:00 on the opposite serial side extending to crown at 10:15. There was polishing visible in the 10:15 opposite serial side region.

There was a one (1) inch wide wheel weight impression on the serial side at 4:00 with a corresponding one (1) inch wide wheel weight on the outboard wheel flange. There was also a 0.5-inch-wide wheel weight impression at 2:45 on the serial side with an outline of a wheel weight corresponding on the wheel flange.

A brown stain was on the serial side sidewall rubber in the 1:30 region. Additionally, the serial side sidewall was cut open in a circular fashion at 2:00.

At 5:15 on the opposite serial side, there was a one (1) inch wide wheel weight impression with a corresponding one (1) inch wide wheel weight on the inboard wheel flange. The opposite serials die sidewall was also dirty.

Rim line polishing to grooving was present 360 degrees on both sides of the tire.

The inner liner was sound.

There were no manufacturing anomalies in the subject tire.

The inner liner was sound.

There were polished worn flanges on the wheel.

E. CONCLUSIONS

Based upon my education, training, experience, and examination of the subject right rear tire and wheel and the three (3) rear companion tires and wheels, the X-rays of the subject tire and a review of the materials provided to date, I have reached the following conclusions:

- 1) The subject tire is not defective or unreasonably dangerous in design or manufacture.
- 2) The subject tire was appropriately designed, manufactured, tested and stamped in compliance with applicable federal regulations and industry standards governing tires. The stated purpose of these regulations is to protect the public against unreasonable risk of accidents involving motor vehicles or motor vehicle equipment including tires. These safety regulations include both performance and tire identification or labeling standards.
- 3) The subject tire experienced a detachment of a portion of the tread and top steel belt. This condition alone does not mean the tire is defective. Tread and steel belt detachments occur for a variety of reasons with the vast majority of tread and steel belt detachments (full and partial) occurring as a result of damage from in-service abuse such as overdeflected operation, cuts, punctures, improperly repaired punctures, wear into the belt structure, fitment issues and/or road hazard impact injuries. The Tire Industry Association published a Passenger & Light Truck Tire Conditions Manual in 2005. This manual is for use by tire service personnel and discusses the above stated comment that tread and top steel belt detachments occur for a wide variety of service related reasons. Additionally, the 2005 NHTSA publication "The Pneumatic Tire", Chapter 15 states that "because the major tire manufacturers have been in business for decades and have extensive research, design, development, manufacturing and quality control activities and procedures – and employ thousands of specially trained scientists, engineers and production personnel – design and manufacturing defects are extremely rare".
- 4) The subject tire was not in a defective condition or unreasonably dangerous at the time it left Goodyear's control. The tire underwent a substantial change in its condition after it left Goodyear. The tire in this case failed because the tire

suffered service conditions and abuses that changed its condition substantially after it left Goodyear. The changes to the tire are included in my inspection notes and photographs.

- 5) The subject tire experienced detachment of a portion of the tread and top steel belt as a result of a localized road hazard impact and overdeflected operation.
- 6) The physical evidence on the subject tire that is consistent with a localized road hazard impact injury includes:
  - a) The partial detachment of the tread and top steel belt,
  - b) the localized region of failure,
  - c) the missing tread and top steel belt in the localized region,
  - d) the multi-level rubber separation and polishing between the steel belts in the localized failure region,
  - e) the lack of any manufacturing or design anomalies in the localized region of the tire as well as anywhere else in the tire.

The 2005 NHTSA publication "The Pneumatic Tire", states that road hazard impacts are one of the most common initiators of tire failures. The publication also states that if, when, and how the tire fails depends on the initial damage pattern and the type and severity of the subsequent operation. If the impact causes a tear between the belts, the damage can propagate and result in a tread/belt separation or detachment. The 2000 International Tire Exhibition and Conference Paper by Harold J. Herzlich titled "The Effect of Snaked Belt Anomalies on Tire Durability" states that the two most common initiators of belt related tire disablements are road hazard injuries to the belt package or other components and underinflation. Additional articles on this subject are the 2005 paper by Standards Testing Labs, "Impact Simulations-What happens when a tire/wheel impacts a road hazard" and the STL paper "Structural Impact Damage Under Varying Laboratory Conditions" presented at the 2006 International Tire Exhibition and Conference. The Tire Industry Association's 2005 Passenger & Light Truck Tire Conditions Manual as well as the 2005 NHTSA publication "The Pneumatic Tire", Chapter 15 also discusses road hazard impact damage to tires.

Additionally, as recent as May 14, 2018 in Rubber & Plastics News, a paper titled "Influence of road hazard impact on radial car tires" was authored by Vandy Price of Michelin and Glenn Follen. This paper was also presented in Europe earlier in 2018 and also at the 2018 Clemson University Tire Symposium in South Carolina as well as at the September 1018 ITEC Conference. I have attached a separate list of "Impact Literature & Reference Materials".

- 7) The physical evidence on the tire and wheel that is consistent with overdeflected operation includes:
- a) the rim line polishing to grooving on both sides of the tire 360 degrees,
  - b) the multi-level radial tear lines on the serial side and the opposite serial side belt edges, and
  - c) the polished worn flanges on the wheel with some black rubber transfer.

I gave a presentation at the September 2004 International Tire Exposition and Conference (ITEC) pertaining to rim line compression grooves. The title of the presentation was "Rim Line Compression Grooves as an Indication of Underinflated or Overloaded Tire Operation in Radial Tires". This conference is held every two years and is one of the premier seminars for presentations and peer review of scientific tire-related research. My paper and others at the ITEC were presented to a broad spectrum of tire industry people, including tire engineers and tire chemists. The paper illustrates rim line compression grooves as a result of controlled evaluations. The paper also studied how overdeflected operation in combination with speed can increase the operating temperature of a tire especially at the belt edges.

Standards Testing Laboratories has also conducted and published three (3) research papers in 1997 and 1998 that support the technical position that rim line compression grooves develop primarily as a result of overdeflected operation. Additionally, the 2001 Northwestern Traffic Investigation Manual, Chapter 8, also discusses rim grooves as an indicator of overdeflected operation.

Rim line compression grooves are an indication of the cumulative overdeflected operation history of a tire.

Overdeflected operation can be caused by overloading, underinflation or a combination of both. Overdeflected operation increases the operating temperature of the tire. Overdeflected operation, depending on the length of time and overall service conditions such as speeds to which the tire is subjected, can damage the tire, including degrading the physical properties of the rubber compounds and reducing a tire's resistance to separation especially at the belt edges.

- 8) The basic design and function of tires, including that they are pneumatic devices, rely on compressed air to provide their designed load carrying capacity. The Tire

and Rim Association load and inflation tables that specify the maximum load carrying capacity for each size tire are based on the volume and pounds per square inch of compressed air inside each tire. As the inflation pressure is reduced inside a tire, the corresponding load carrying capacity is reduced. Additionally, as demonstrated in various technical papers, when a tire is operated underinflated, the operating temperature as well as the stresses and strains at the belt edges increases. Ref, "The Pneumatic Tire", edited by A. N. Gent and J. D. Walter, Published 2005 by NHTSA and "The Effect of Underinflation on Tire Operating Temperature", Jenny Paige, ITEC 2012.

- 9) The remaining rubber over the bottom steel belt in the crown region, where the tread and top steel belt was detached, was worn with lateral abrasion indicating that the subject tire remained inflated for some initial part of the accident sequence. The curved cut through the outboard serial side sidewall at 2:00, would have had to occur later in the accident sequence or as a result of post-accident damage. There were also a few permanent bends in the bottom steel belt that would have occurred toward the end of the accident sequence and or as a result of post-accident moving of the vehicle.
- 10) I disagree with Mr. Southwell's defect contentions and criticisms of the subject tire.
- 11) The exposed rubber over the bottom steel belt in the crown region was worn with lateral abrasion marks. The exposed rubber was also dirty. I disagree with Mr. Southwell's opinion that the rubber on the crown region is hard and brittle (more than he would expect). Mr. Southwell's photo 52 in his report that he uses to support shows dirty worn rubber in the crown with lateral abrasion marks. The rubber is not hard or brittle. The rubber shown in photo 52 as well as other areas on the detached surfaces is supple and show excellent multilevel tearing and excellent rubber to steel adhesion.
- 12) The multi-level tearing and rubber tear appearance of the exposed detached surfaces of the belt skim rubber are evidence that the overall rubber to rubber and rubber to steel adhesion levels as well as the fatigue resistance, age resistance and physical properties, such as rubber strength and tear strength of the belt skim compound, were appropriate in the subject tire. The multi-level tearing of the rubber between the steel belts is also evidence that there was good balanced adhesion between all the various interfaces of the laminate structure. There is no physical evidence of any inadequate bonding or adhesion deficiency or premature aging of the belt skims in the subject tire. There is also no evidence of insufficient antidegradants either by design or through manufacturing exceptions to counteract the degree of oxygen attack. These

types of manufacturing and/or design deficiencies would influence the tire 360 degrees around the tire. The steel cords overall are encased in rubber. The tire randomly tore apart in a multi-level way indicating good balanced adhesion and appropriate physical properties of the rubber. References: "Component Interfacial Tearing Appearances" by Gary Bolden and TIA 2005 – "Passenger & Light Truck Tires Conditions Manual".

- 13) The tire scientific community of tire engineers and chemists worldwide has known for decades that tread/belt separations and detachments can and do occur from impact damage and that the final failure of the tire from a tread/belt separation can occur days, weeks, and even months after the impact damage has occurred. This is part of the body of knowledge of tire engineers and chemists. The Tire Industry Association's 2005 Passenger & Light Truck Tire Conditions Manual as well as the 2005 NHTSA publication "The Pneumatic Tire", Chapter 15 also discusses road hazard impact damage to tires leading to tread/belt separations and detachments. I have attached a separate list of "Impact Literature & Reference Materials".
- 14) The tire scientific community of tire engineers and chemists worldwide has known for decades that tread/belt separations and detachments can and do occur from overdeflected operation. This is part of the body of knowledge of tire engineers and chemists. The Tire Industry Association's 2005 Passenger & Light Truck Tire Conditions Manual as well as the 2005 NHTSA publication "The Pneumatic Tire", Chapter 15 also discusses overdeflected operation in tires leading to tread/belt separations and detachments. I have attached a separate list of "Overdeflected Operation Index" of materials".
- 15) The 2013 Rubber Manufacturers Association "RMA" publication "Tire Care & Safety" states that "Continuous use of a tire in an under inflated condition will result in heat build-up and internal damage. This may result in a tire failure, including tread/belt separations". This same publication states that "Impact damage to the tire may initially show little or no external evidence. However, internal damage can progress with additional mileage and eventually cause internal tire separation, detachment or sudden loss of inflation".
- 16) There is no physical evidence of thermos-oxidative degradation in the subject tire. The localized region of multi-level rubber tearing is not related to oxidative degradation or rubber reversion related oxidative degradation. The rubber-to-rubber adhesion was excellent and the rubber between the steel belts was still supple and not brittle or cracked. The subject tire experienced a localized failure as a result of a localized road hazard impact injury and overdeflected operation.



- 17) Mr. Southwell states that there was an unexpected smooth and polished area on the opposite serial side at 150 degree. He uses photograph 53 to show this area in his report. He is incorrect that this location is at 150 degrees. This location is actually at approximately 310 degrees on the opposite serial side. This is the polishing that occurred in the localized region of failure as a result of the localized separation growing in the tire from the road hazard impact. This is a very normal and expected condition in a tire with a separation that is continued to be used in service. This polished area is not indicative of an adhesion anomaly as indicated by Mr. Southwell. The area of polishing is over multi-level rubber fracture tear lines and not at a manufactured interface as indicated by Mr. Southwell.
- 18) It is speculation by Mr. Southwell that the so called "wild wire" that shows up in the X-Rays at approximately 50 degrees in the serial side shoulder region is actually a "wild wire". The term wild wire typically is related to a manufacturing condition. It is also speculation to call it a single frayed second belt filament. It is not possible to conclude that the object noted in the X-Ray was actually from the tire (bottom or top belt). The tire experienced a tread and top steel belt detachment and went through an accident sequence that included the tire at some point even rotating deflated. It is no unusual for tires to experience broken steel cords and filaments to become lodged in various areas of the tire including through the inner liner. Tires also get punctured and pickup various external objects during a tire disablement and accident sequence. What can be concluded with a high degree of engineering certainty is that the object had nothing to do with the localized failure of the tire, and was actually in an area where the tire was intact and did not fail.
- 19) It is speculation by Mr. Southwell to state the tread was most probably devoid of any visual indicators that would, to the average person, suggest was in any way unsuitable for normal use. The portion of the tread that was detached was not recovered. A portion of this missing detached tread was over the localized separation regions of the tire. It is not possible to opine that this missing tread would not have had any physical evidence on it from a road hazard impact as well as any evidence of localized accelerated tread wear.
- 20) Mr Southwell's comments and literature referenced in his report regarding the opinion that tires must wear out before they fall apart assumes something very important that he does not mention in his report. Tires will wear out before they fall apart only if they are properly maintained, used and stored. Tires require maintenance. Many tires need to come out of service or are taken out of service before they wear out as a result of many different service related conditions. As an example tread and steel belt detachments such as encountered with the

subject tire occur for a variety of reasons with the vast majority of tread and steel belt detachments (full and partial) occurring as a result of damage from in-service abuse such as overdeflected operation, cuts, punctures, improperly repaired punctures, wear into the belt structure, fitment issues and/or road hazard impact injuries. The Tire Industry Association published a Passenger & Light Truck Tire Conditions Manual in 2005. This manual is for use by tire service personnel and discusses the above stated comment that tread and top steel belt detachments occur for a wide variety of service related reasons. The subject tire failed as a result of a localized road hazard impact and overdeflected operation.

- 21) There is nothing unusual about the steel belts in the subject tire that would be of concern related to tire durability. I reviewed the x-rays of the subject tire, and there is nothing unusual about the steel belts in the subject tire that would be of concern related to tire durability. Based on my examination of the subject tire and X-rays, the steel belts are in line with well-manufactured tires and did not cause any tire durability issue in the subject tire.

I have also analyzed belt cord conditions on a large number of tires in my career, including tires manufactured by a variety of tire manufacturers both in new tires and worn tires. Additionally, on September 18, 2012, at the 2012 International Tire Exposition and Conference "ITEC", in Cleveland, Ohio, I presented a paper pertaining to an X-ray study of sixty (60) worn out passenger and light truck tires that I conducted. Recent shearography was performed on the 60 worn out tires. The shearography results further supports the opinions in the paper. This study confirms that the belt conditions in the subject tire and the companion tires are normal and are not a concern related to durability. In my experience, the steel belts in the subject tire, based upon my examination, are in line with hundreds of millions of well-manufactured radial tires produced in the United States and worldwide over the years and did not cause or contribute to the failure of the tire.

Additional technical papers that support this include: "Belt Misalignments and Belt/Belt Tear Patterns" ITEC 2002 and "The Effect of Snaked Belt Anomalies on Tire Durability" ITEC 2000 both by Harold J. Herzlich of Herzlich Consulting, Inc.

- 22) I have conducted thermography demonstrations of passenger and light truck tires that have been X-Rayed. These demonstrations were conducted to show the significant heat generated in the steel belt area when a tire is run overdeflected. These same demonstrations showed no increase in the heat generated at the regions of the belt conditions similar to the alleged belt conditions in the subject tire and normally found in tires. The results of this

testing were presented at the September 2016 International Tire Exhibition and Conference (ITEC) in Akron, Ohio in a paper titled "Typical Manufacturing Conditions in Steel Belted Radial Tires: Do They Influence Tire Durability?". The paper was also recently published in the "2017 Tire Technology International Annual".

- 23) All tires, as well as most other manufactured products, are designed and manufactured with tolerances. The tolerances for the various parameters of the steel belt manufacturing have historically been established recognizing the manufacturing capabilities, and the importance of making sure there are tight controls in place to insure all tires manufactured will perform the same for consumers for performance considerations such as ride, handling and durability. Tolerances are not a cliff where as soon as a tire has a belt condition slightly outside the tolerances that a performance or durability issue will arise. Tolerances are set up to ensure the manufacturing of tires is held to high standards and to insure a typical or normal belt condition does not cause a performance or durability issue in a tire. The belt conditions in the subject tire are normal expected belt conditions found in any well manufactured tire and did not cause or contribute to the subject tire failure.
- 24) The taking of X-Rays of the steel belts in a tire must be done with caution and consideration of the normal distortion and parallax that occurs in the X-ray process. Interpretation and measurements taken off X-Rays must also be recognized as being subject to ray distortion and parallax. Chapter 16 of the NHTSA "The Pneumatic Tire" publication discusses this issue as does my 2012 International Tire Exposition and Conference "ITEC" paper pertaining to an X-ray study of sixty (60) worn out passenger and light truck tires that I conducted.
- 25) The inner liner thickness is not defective in the subject tire and in my experience is in line with well-manufactured radial tires sold and used in the United States over the years. The subject tire does not have any exposed or penetrating body ply cord. The inner liner did not cause or contribute to the localized failure of the tire.
- 26) Increasing rubber gauges of components such as increasing the inner liner gauge does not necessarily improve tire durability. Unnecessary increases in rubber gauges can actually reduce component and overall tire life. Unnecessary increases in rubber gauges of rubber components increase tire weight, increase tire operating temperature and can increase the stresses and strains in the tire. The design approach to tires is to optimize each component in the tire to obtain the required tire performance.

27) A nylon cap ply would not have prevented this tread and steel belt detachment on the tire from occurring. Nylon cap plies placed circumferentially (0 degrees) over the steel belts in radial tires do not offer sufficient stiffness and support to the steel belt edges to have an influence on the various stresses and strains that the belt edges must endure during the tire's operational life.

Nylon cap plies or strips placed circumferentially (0 degrees) over the steel belts do not prevent belt edge separation and tread/belt detachment when a tire has been run overdeflected, damaged, improperly repaired or injured. I have personally examined many tires with nylon cap plies or nylon strips that have experienced tread and top steel belt detachments.

Nylon cap plies or strips are used to increase high speed performance and are mainly used in high speed rated tires. I have reviewed many competitor radial tires over my career, all of which confirm this knowledge.

Nylon cap plies or strips mainly offer an advantage in restricting a high speed rated high performance tire's outside circumference from growing due to centrifugal forces at high speeds and also delaying the formation of standing wave patterns. This is because the nylon is placed in the tire in a circumferential direction and has low elongation properties.

I gave a presentation in October 1986 to The Tire Technology Conference at Clemson University in Greenville, South Carolina. The title of the presentation was "What makes a High Performance Tire Different than a Regular Tire?" This conference is held annually and is attended by a broad spectrum of tire industry people, including tire engineers and tire chemists. This particular paper presentation was very well received and reflects the understanding of the tire industry in regard to the use of nylon cap plies and cap strips. This same presentation was also presented at the Akron Rubber Group in Akron, Ohio and at the American Retreaders Association's annual convention in Louisville, Kentucky.

I also continue to examine tires that do have full width nylon cap plies that have experienced tread and top steel belt detachments. The full width nylon cap has not prevented or minimized the tread and top steel belt detachment from occurring.

In sum, nylon cap plies or strips are used as a method to increase high speed performance and reduce the formation of standing wave patterns and not as a method to stop or prevent belt edge separations and tread/belt(s) detachments from occurring.

- 28) I disagree that there were safer alternative designs such as nylon or aramid or polyamide as overlays that would have made the tire more durable and/or more resistant to foreseeable road hazards. The subject tire already has two (2) steel belts. This type of construction has proven over a number of decades to be extremely durable. These alternative designs would not have prevented or significantly reduced the risk of the subject tire's disablement.
- 29) The subject tire was manufactured in 1994, twenty-one (21) years before the accident. The subject tire's design and construction was state of the art for light truck tires manufactured in 1994. The vast majority of radial light truck tires designed and manufactured in the United States at the time of the manufacture of the subject tire incorporated two (2) steel belts and did not incorporate a nylon cap ply.
- 30) There is no condition in the subject tire that suggests that Goodyear's quality assurance processes were inadequate. The alleged defective conditions are not defects and did not cause or contribute to the subject tire disablement. The tire experienced a tread/belt detachment as a result of service conditions.
- 31) The subject tire (and companion tires) should not have been in service on the day of the accident. The person responsible for maintaining and inspecting the subject tire should have taken remedial action and removed the subject tire (and companion tires) from service before the accident. Additionally, the tread over the localized region where the subject tire failed would have appeared distorted leading up to the crash. An increase in noise and vibration from the tire leading up to the tire failure would also have been signals to most drivers that the tire needed to be replaced. There is an SAE Paper 2007-01-0733, titled "Vehicle Response Comparison to Tire Tread Separations Induced by Circumferentially Cut and Distressed Tires" by a number of gentlemen from Tandy Engineering & Associates, Inc. and Ford Motor Company. As part of "distressing" the tires in order to achieve a tread/belt separation on a vehicle in a relatively short period of time, they dropped the inflation pressure to 15 psi and drove on the tire at approximately 70 miles per hour on the right rear position of a 1999 Ford Explorer. After approximately four hours, the tire failed as a result of a tread/belt separation and detachment. The paper states that the forces from the vibrations from the distressed tire increased in amplitude over many miles, up to the point of the tread/belt separation. The paper also states that the vibration can be signals to the driver that something is occurring. These signals were measured and documented for approximately 300 miles of driving in this paper.